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April 23, 2004

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FILING DATE: *July 24, 2003*

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Certifying Officer

PATENT APPLICATION SERIAL NO. ____________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

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17691 U.S. PTO 07/24/03

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

16235 U.S. PTO 60/489606 07/24/03

INVENTOR(S)

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☐ *Additional inventors are being named on the____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

Electric Fluid Pump

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* [4] ☐ CD(s), Number [ ]

☒ Drawing(s) *Number of Sheets* [3] ☐ Other (specify) [ ]

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

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FILING FEE AMOUNT ($): **$160.00**

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: __________

Respectfully submitted,

SIGNATURE Jay S. Paranjpe

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Date [07/24/2003]

REGISTRATION NO. *(if appropriate)* [45,486]

Docket Number: [19345-094575]

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on July 24, 2003 and is addressed to: Mail Stop Provisional Patent Application, Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450

By:
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Attorney Docket No 19345-094575

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US Provisional Patent Application

Electric Fluid Pump

ELECTRIC COOLANT PUMP

Field of the Invention

The invention relates to a pump driven by a brushless direct current motor. More particularly, the invention pertains to any fluid pump system using DC brushless motor technology to drive coolant (for water pumps) or oil (for engine and transmission pumps).

Background of the Invention

The most common pump accessory arrangement found in automobiles utilizes the engine rotation to drive a shaft via a belt connection between a driving pulley (connected to the crankshaft) and a driven pulley. These belts and pulleys are cumbersome, bulky, noisy, and transfer power (torque) inefficiently. Another disadvantage is that these pumps have their output dictated by the rotational speed of the engine. Certain accessories that are coupled to the engine, such as the water and oil pumps, must be over-sized, because the pump output must deliver a minimum flow amount of fluid at low engine speeds. At higher engine speeds, such as those experienced under normal highway driving conditions, the flow amount becomes excessive because it is directly proportional to engine speed, which is up to an order of magnitude greater. This leads to poor efficiencies and increased power losses due to the requirement for a bypass.

Therefore, it is desirable to have the pump output to be independent of the engine speed, and to be adjustable to match the operating conditions.

Summary of the Invention

The present invention relates to a pump or other accessory whose output is adjustable and is driven independently of the engine. An electric motor replaces the traditional belt and pulley combination.

The preferred motor of the present invention employs direct current (DC) brushless technology. For any DC motor to operate, the electric current to the motor coils must be continually

switched relative to the field magnets. For commutation to occur, power is applied to the motor's windings to produce torque. In a brush-type motor, carbon brushes contact a slotted commutator cylinder, which has each motor coil, connected to a corresponding bar of the commutator. Brushless motors differ in that the windings are located on the stator and do not move, while the magnets are on the rotor. The position of the rotor is sensed and continually fed back to an electronic commutation control to provide for appropriate switching. Advantages of brushless motors include improved efficiencies, reduced noise, weight and size, and improved durability.

In a broad aspect, the invention relates to the integration of a brushless DC motor wherein the mechanism to be driven is integral with the motor and not driven through some sort of mechanical coupling. The brushless motor is the actual driving mechanism.

One of the general objects of the invention is to apply brushless DC motors for pump systems for use in automobiles, although the invention has utility in more general use. More particularly, the invention pertains to any fluid pump system using DC brushless motor technology to drive coolant (for water pumps) or oil (for engine and transmission pumps).

In a particular embodiment, the fluid pump comprises a housing that includes a plurality of components fastened together, an impeller, a rotor, and a stator with associated windings. The impeller is rotatedly mounted within the pump housing for rotation about a rotary axis, in order to force fluid to flow through the outlet. The rotor is permanently coupled to and rotatable with the impeller, and consists of a permanent magnet. The stator is spaced apart from and generally facing the permanent magnetic poles on the rotor. A plurality of magnetic windings are positioned on the stator and serve to effect rotation of the rotor and impeller upon energization.

In an alternate embodiment, the rotor and impeller form a unitary body, in order to reduce the number of parts.

Further aspects of the invention are hereinafter described in the following description and drawings.

Description of the Drawings

In drawings which illustrate the embodiments of the invention,

Figure 1 is a cut-away view of the pump in accordance with the present invention;

Figure 2 is a perspective view of the pump shown in Figure 1 with many of the parts exploded; and

Figure 3 is an electrical schematic of the motor and control circuit.

Detailed Description of the Invention

Referring to Figures 1 and 2, the pump 100 includes an upper housing 12 with an inlet 10 and outlet 11. In the interior volume, an impeller 9, preferably formed from injection-molded plastic, is present. The impeller is integrally formed with a permanent magnet 8, which also serves as the rotor of a DC motor, to be described shortly. In one embodiment, the plastic impeller 9 encapsulates the magnet 8 due to an overmolding or insert molding operation. Both the impeller 9 and rotor 8 include a central opening to accommodate both a sleeve bearing 13 and low friction shaft or spindle 14. The upper housing has non-threaded inserts 29-32 that align with threaded inserts 16-20 in the lower housing and which accept bolts 21-25 during assembly and attachment of the two housings.

A simple gasket 26 serves to seal the upper housing from the lower motor housing 15, which includes a DC motor of the brushless type, with a stator 7 surrounded by windings 4,5,6. The lower housing 15 is enclosed at the bottom end by an O-ring 27 and end cap 28.

The DC motor includes semiconductor components (not shown) such as Hall Effect sensors. The sensors determine the angular position of the magnetic field of the rotor magnet 8. Signals from the sensors are passed through to a circuit board, which is part of the electronic assembly 3 located in the distal end of the pump housing. The control circuit, illustrated schematically in Figure 3, also includes a driving transistor (not shown) for controlling a driving current to be supplied to the stator windings 4, 5, 6, so that the rotor magnet 8 may be rotated under the control of the circuit.

In a slight variation of the above arrangement, the impeller and rotor are present as a single member. In this case, a suitable construction material would be plasto-ferrite. In this structure, a thermoplastic such as polypropylene serves as the matrix, with strontium ferrite or other suitable magnetic material embedded within. The advantages provided by a single impeller-rotor assembly include easier manufacturing and assembly, and fewer parts.

In operation, the power source is connected to the terminals 1, 2 of the electronic assembly 3. Upon application of an appropriate voltage, the electronic circuit of the electronic assembly 3 energizes the windings 4, 5, 6 in a predetermined pattern. This switching pattern causes the windings to generate a rotating magnetic field within the stator core 7. This rotating magnetic field interacts with the magnetic field generated by the permanent rotor magnet 8, causing the rotor to rotate.

Since the rotor 8 is either embedded within the impeller 9, or is the same part, the impeller 9 rotates in direct response to the rotation of the rotor 8 with no coupling or power transfer assembly required. The number of components and physical size of the pump are thus reduced. The impeller 9 includes curved vanes (not labeled) that impart centrifugal energy to the fluid passing through inlet 10, urging the fluid to flow under pressure through outlet 11. When the power source is removed the magnetic field in the core collapses and the impeller stops rotating.

Although the invention has been described in detail with reference to a specific preferred embodiment, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.

Figure 1

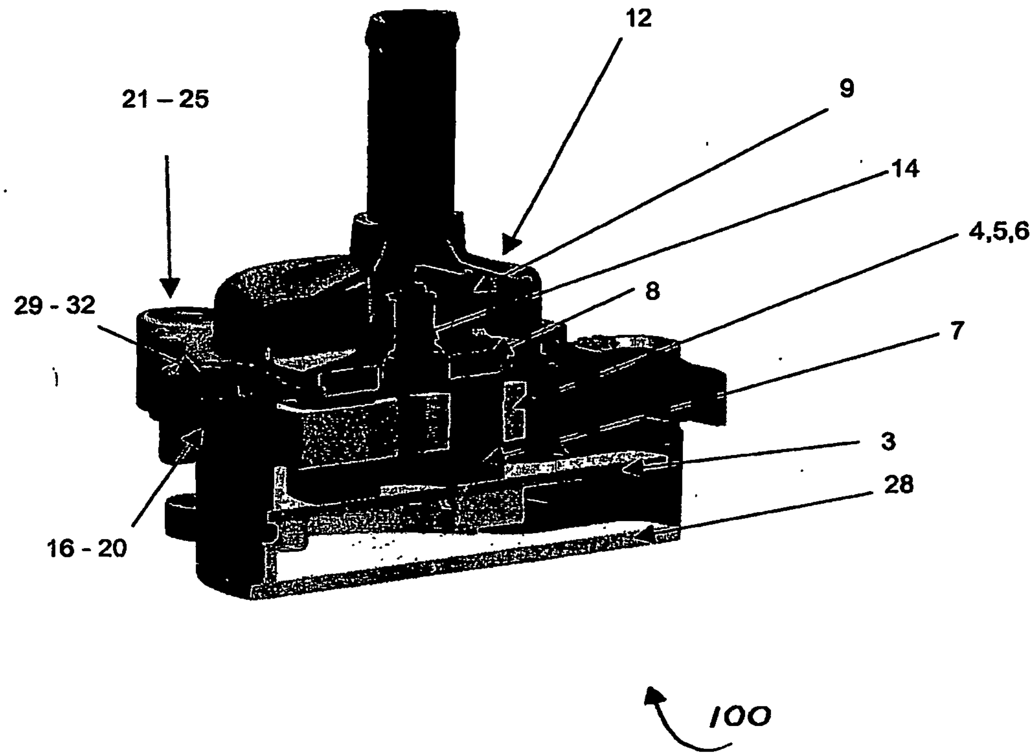


Figure 2

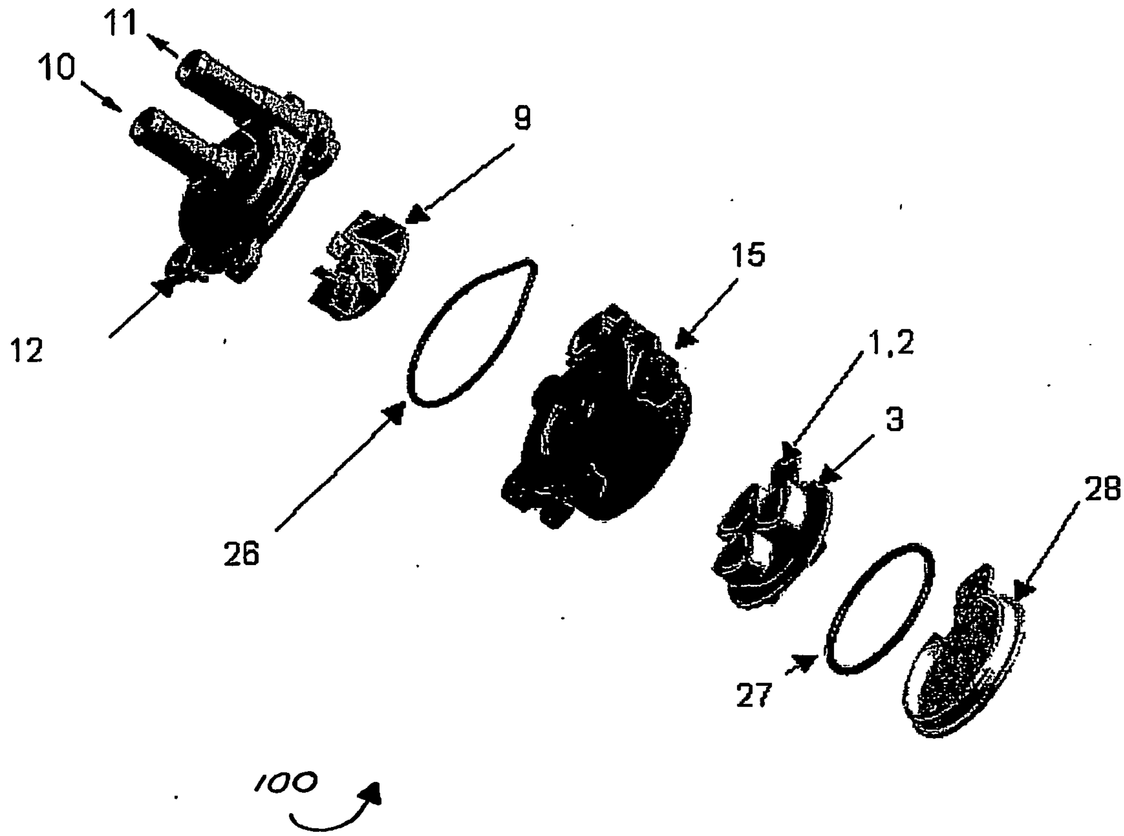
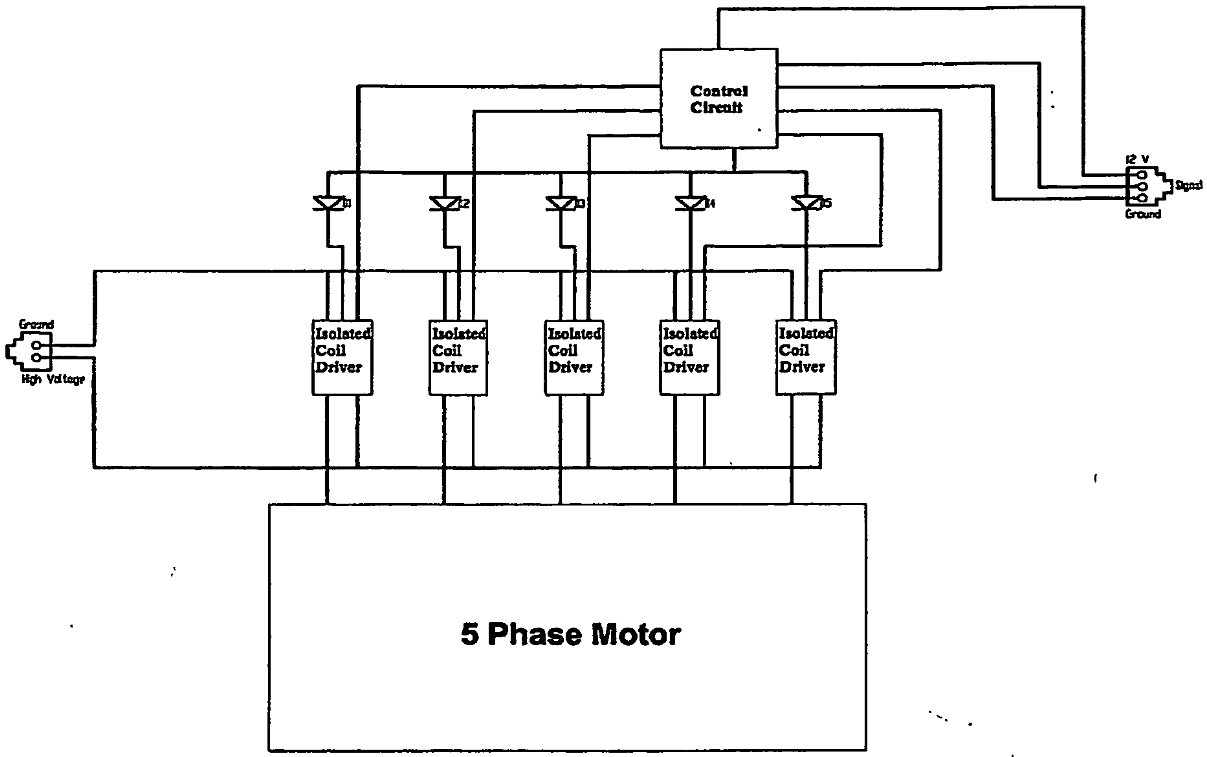


Figure 3


Control Circuit
12 V
Signal
Ground
Ground
High Voltage
Isolated Coil Driver
Isolated Coil Driver
Isolated Coil Driver
Isolated Coil Driver
Isolated Coil Driver
5 Phase Motor